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[Abstract]

PURPOSE: To apply and form plural paste patterns of a desired form on a substrate simultaneously, with high precision and at high speed by making the control of the opposite distance between a nozzle and the substrate be independent of that of the horizontal relative movement of the two.

20 CONSTITUTION: This applicator is provided with nozzles 1a, 1b, optical range finders 3a, 3b for individually measuring the opposite distance between an discharge port of each nozzle and the surface of a substrate 7, tables 6, 8 controlled by a main controller 14a and for horizontally and relatively moving each  
25 nozzle and the substrate 7, and an auxiliary controller 14b for individually

controlling the opposite distance between the discharge port of each nozzle and the surface of the substrate 7 by using data of each optical range finder 3a, 3b on the relative movement.

[Claims]

1. A paste applicator for laying a substrate on a table to face each paste discharge port of nozzles, changing a relative position relation between the nozzles and the substrate with discharging a paste stored in a paste syringe on the substrate through the paste discharge port, and drawing a paste pattern with a  
5 desired shape on the substrate, the paste applicator comprising:

a plurality of nozzles;

a plurality of measurement units for individually measuring a facing interval between the paste discharge port of each nozzle and a surface of the  
10 substrate;

a movement unit for relatively moving each nozzle and the substrate in a longitudinal direction; and

a control unit for individually controlling the facing interval between the paste discharge port of each nozzle and the surface of the substrate by using  
15 measured data from each measurement unit in the relative movement.

2. The paste applicator of claim 1, wherein the plurality of nozzles individually discharge the paste on a plurality of the substrates laid on the table, and simultaneously the movement unit relatively moves each nozzle and each  
20 substrate in the longitudinal direction by the same amount and at the same time.

3. The paste applicator of claim 1 or 2, wherein the control unit is provided with a storage unit for storing the measured data from each measurement unit.

[Title of the Invention]

Paste applicator

[Detailed Description of the Invention]

5 [Field of the Invention]

The present invention is related to a paste applicator for drawing a plurality of paste patterns having a desirable shape on a substrate at the same time by discharging a paste on the substrate positioned on a table through a plurality of nozzles and relatively moving the substrate and the nozzles.

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[Description of the Prior Art]

An example for a paste applicator for drawing a paste pattern on a substrate using a discharge patterning technique, for which a substrate positioned on a table faces a nozzle fixed to a front end of a paste syringe for storing the paste, and the paste is discharged from a paste discharge port of the nozzle and at least one of the nozzle and the substrate is moved in a longitudinal direction to change a relative-position relation therebetween, is disclosed in Japanese Laid Open Publication No. 2-52742.

15 This paste applicator includes one nozzle and a controller for controlling a position of the nozzle or a substrate, by which a resistance paste is discharged on an insulating substrate used as the substrate through a paste discharge port positioned at a front end of the nozzle, to form a resistance paste pattern with a desired shape on the insulating substrate.

25 [Problems to be Solved by the Invention]

However, in general, some concavo-convex exists on a surface of the substrate on which a paste pattern is supposed to be drawn. As a result, when high precision is required for a drawing width or a drawing height as well as a portion where the patterned paste is drawn, the nozzle and the substrate are relatively moved in a longitudinal direction and a facing distance between the nozzle and the surface of the substrate is measured to control the distance therebetween to be within a desired area. In the prior art, such operations are all controlled by one controller, which causes difficulty in the control therefor. As a result, a patterning speed is lowered and a fabricating speed or an output is easily determined by this paste patterning process in fabrication facilities for massive production. Therefore, in order to increase productivity, a plurality of paste applicators must be installed. However, in this case, producing lines are complicated, and spaces for fabrication facilities must be enlarged, which results in increase of product prices due to increase of initial cost.

Therefore, in order to solve problems of the prior art, an object of the present invention is to provide a paste applicator capable of simultaneously drawing a plurality of paste patterns with a desired shape on a substrate with high precision at a high speed.

#### [Means for Solving the Problem]

To achieve the above object of the present invention, a paste applicator by which a substrate is positioned on a table to face a paste discharge port of each nozzle, a paste received in a paste syringe is discharged onto the substrate from the discharge port and simultaneously a relative position relation between the nozzle and the substrate is changed, and a paste pattern having a desired shape

is patterned on the substrate, the paste applicator including: a plurality of nozzles;  
a plurality of measurement units for individually measuring a facing interval  
(distance) between a paste discharge port of each nozzle and a surface of the  
substrate; a movement unit for relatively moving each nozzle and the substrate in  
5 a longitudinal direction; and a control unit for individually controlling the facing  
interval (distance) between the paste discharge port of each nozzle and the  
surface of the substrate by using the measured data of each measurement unit  
during the relative movement.

In the present invention, the movement unit for relatively moving each  
10 nozzle and the substrate in the longitudinal direction differs from the control unit  
for individually controlling the facing interval between the paste discharge port of  
each nozzle and the surface of the substrate, wherein the facing interval can be  
controlled independent of controlling the relative movement in the longitudinal  
direction, whereby a measurement period by each measurement unit is set to be  
15 shortened to increase the number of times for measurement, which leads to a  
control of the facing interval with high accuracy. As a result, the paste can be  
discharged on the substrate by making each nozzle follow concavo-convex of the  
surface of the substrate which the nozzles respectively face, thereby obtaining a  
plurality of paste patterns with a desired shape at the same time.

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#### [Embodiment of the Invention]

Hereinafter, preferred embodiments of the present invention will be  
explained with reference to attached drawings.

Figure 1 is a schematic perspective view illustrating one embodiment of a  
25 paste applicator according to the present invention. In this drawing, 1a and 1b

denote nozzles, 2a and 2b denote paste syringes, 3a and 3b denote optical range finder, 4a and 4b denote Z-axis tables, 5 denotes an X-axis table, 6 denotes a Y-axis table, 7 denotes a substrate on which paste patterns are patterned, 8 denotes a  $\theta$ -axis table, 9 denotes a mounting unit, 10 denotes a Z-axis table supporter, 11a and 11b denote image-identifying cameras, 12a and 12b denote nozzle support units, 13 denotes a sucking base for absorbing and fixing the substrate 7, 14a denotes a main controller, 14b denotes an auxiliary controller, 15 denotes an image processor, 16 denotes an external storage device, 17 denotes an image monitor, 18 denotes a display for displaying a condition processed by both controllers 14a and 14b, 19 denotes a keyboard, 20a and 20b respectively denotes lens barrels of the image-identifying cameras 11a and 11b, 21a and 21c to 21e denote servomotors, and 22 denotes a camera supporter. Furthermore, in order to avoid inconvenience of the drawing, X-axis table and Y-axis table of the Z-axis tables 4a and 4b with respect to the Z-axis table supporter 10 are not shown in the drawing.

In the same drawing, the X-axis table 5 is fixed onto the mounting unit 9, and the Y-axis table 6 is mounted on the X-axis table 5 to be movable in the X-axis direction. The  $\theta$ -axis table 8 is mounted on the Y-axis table 6 to be movable and rotatable in the Y-axis direction, and the sucking base 13 is fixed onto the  $\theta$ -axis table 8. The substrate 7, for instance, is sucked and fixed onto the sucking base 13 so that each line of the substrate is to be parallel in directions of X-axis and Y-axis.

The substrate 7 mounted on the sucking base 13 can move toward each direction of X-axis and Y-axis by driving the main controller 14a. That is, when the servomotor 21a is driven by the main controller 14a, the Y-axis table 6 moves to

the X-axis direction and thusly the substrate 7 is moved to the X-axis direction. Additionally, when the servomotor 21b indicated in R>3 as shown in Figure 3 is driven by the main controller 14a, the  $\theta$ -axis table 8 moves to the Y-axis direction and thusly the substrate 7 moves to the Y-axis direction.

5           Therefore, when the Y-axis table 6 and the  $\theta$ -axis table 8 move as much as an arbitrary distance, respectively, by the main controller 14a, the substrate 7 moves as much as an arbitrary distance toward a certain direction within a surface parallel to the mounting unit 9. In addition,  $\theta$ -axis table 8 can be rotated as much as a certain amount toward the  $\theta$ -axis direction from its center by the servomotor  
10   21e.

          The Z-axis table supporter 10 is installed on the mounting unit 9, and the Z-axis tables 4a and 4b are installed on the Z-axis table supporter 10 to be movable in the Z-axis direction (i.e., a upper and lower direction). One Z-axis table 4a of the two tables has thereon the nozzle 1a, the paste syringe 2a, or the optical  
15   range finder 3a, while the other Z-axis table 4b has thereon the nozzle 1b, the paste syringe 2b, or the optical range finder 3b. These Z-axis tables 4a and 4b are driven to move in the Z-axis direction by the auxiliary controller 14b. That is, when the servomotors 21c and 21d are driven by the auxiliary controller 14b, the Z-axis tables 4a and 4b move to the Z-axis direction, and accordingly the nozzles 1a and  
20   1b, the paste syringes 2a and 2b, or the optical range finders 3a and 3b move toward the Z-axis direction. Furthermore, the nozzles 1a and 1b are installed at each front end of the paste syringes 2a and 2b, however, have a short distance from each lower end of the paste syringes 2a and 2b through the support units 12a and 12b having a connection portion, respectively.

25           The optical range finders 3a and 3b measure a distance from the paste



discharge port which corresponds to the front end (or lower end) of each nozzle 1a and 1b and a surface of the substrate 7 depending on a non-conjunction triangulation.

That is, these optical range finders 3a and 3b have the same formation.

- 5 Thus, one range finder 3a will now be explained with reference to Figure 2. A lower portion of the optical range finder 3a is cut off in a triangle. A luminous element is installed in one side of two curved surface facing this cutoff part, while a light receiving element is installed in the other side thereof. The nozzle support unit 12a is installed in a front end of the paste syringe 2a to be extended up to a
- 10 lower portion of the cutoff part of the optical range finder 3a, and the nozzle 1a is installed at a lower surface of the front end part. The luminous element installed in the cutoff part of the optical range finder 3a, as indicated by one-dot chain line in the drawing, irradiates light on an adjacent area directly under the paste discharge port of the nozzle 1 and the light receiving element then receives reflected light
- 15 from the irradiated area. When a distance between the paste discharge port of the nozzle 1a and the substrate 7 (refer to Figure 1) arranged at a bottom side of the discharge port is within a predetermined range, a relation between positions where the nozzle 1a and the optical range finder 3a are aligned is established such that the light from the luminous element can be received in the light receiving element.
- 20 When the distance (facing interval) between the paste discharge port of the nozzle 1a and the substrate 7 is changed, a position of the irradiation point (hereinafter, referred to as a measurement point) of the light from the luminous element on the substrate 7 is changed in the adjacent area directly under the discharge port to thereby fluctuate a receiving state of the light receiving element, which results in
- 25 enabling a measurement for the distance between the paste discharge port of the

nozzle 1a and the substrate 7.

As will be explained later, while the substrate 7 moves in the X-axis and Y-axis directions to form a paste pattern, when the irradiation point (hereinafter, referred to as a measurement point) of the light from the luminous element on the substrate 7 crosses the paste pattern having already formed, a measured value  
5 for the distance between the paste discharge port of each nozzle 1a and 1b and the surface of the substrate 7 by the optical range finders 3a and 3b may have error as much as a thickness of the paste pattern. Accordingly, in order to prevent the measured point from crossing the paste pattern as rare as possible, the  
10 measured point can be assigned in a position deviated from a paste drop point (hereinafter, referred to as a drawing point) onto the substrate 7 through the nozzles 1a and 1b toward a curved direction with respect to the X-axis and the Y-axis.

In addition, when the paste in the paste syringes 2a and 2b is completely  
15 used, the nozzle exchange is carried out. The nozzles are installed such that the drawing point can be equivalent to a designated position for drawing the paste thereon. However, the positions of the nozzles may be changed before or after the nozzle exchange due to such non-uniform characteristics of installation precision of the paste syringes 2a and 2b, the nozzle support units 12a and 12b, or the  
20 nozzles 1a and 1b. However, as shown in Figure 2, when the drawing point is positioned within an allowable range ( $\Delta X$  and  $\Delta Y$ ) having a preset size based on the designated position, the nozzles 1a and 1b are considered as being normally installed. Here,  $\Delta X$  denotes a width of the X-axis direction of the allowable range, while  $\Delta Y$  denotes a width of the Y-axis direction thereof. The image-identifying  
25 cameras 11a and 11b are used when identifying the position of each nozzle 1a

and 1b after being exchanged or when measuring an interval of these nozzles 1a and 1b.

When data is applied from each optical range finder 3a and 3b or each image identifying camera 11a and 11b, the main and auxiliary controllers 14a and 14b drive the servomotors 21a through 21e. Data indicating a driving condition of each motor 21a through 21e are fed back to both the controllers 14a and 14b from each encoder installed in these servomotors 21a through 21e.

In such construction, when the square substrate 7 is laid on the sucking base 13, the sucking base 13 absorbs the substrate 7 in a vacuum state and fixes it. According to rotation of the  $\theta$ -axis table 8, each line of the substrate 7 is set to be parallel to the X-axis and the Y-axis, respectively. Afterwards, on the basis of the result measured by the optical range finders 3a and 3b, the servomotors 21c and 21d are driven, and accordingly the Z-axis tables 4a and 4b move toward a lower side and make the nozzles 1a and 1b move downwardly from an upper side of the substrate 7 until the distance between the paste discharge port of each nozzle 1a and 1b and the surface of the substrate 7 corresponds to a designated distance.

Thereafter, the paste supplied from the paste syringes 2a and 2b through the nozzle support units 12a and 12b is discharged onto the substrate 7 through the paste discharge port of each nozzle 1a and 1b. In addition to this, the Y-axis table 6 and the  $\theta$ -axis table 8 appropriately move by driving the servomotors 21a and 21b (See Figure 3). As a result, the paste is drawn in a desired pattern simultaneously at two parts on the substrate 7. Since the pattern to desirably form can be converted into the distance of each direction of the X-axis and the Y-axis, when data for forming the pattern with the desired shape is inputted from a

keyboard 19, the main controller 14a converts the inputted data into the number of pulses sent to the servomotors 21a and 21b, and thus outputs a command. As a result, the patterning process is automatically performed.

Figure 3 is a block diagram illustrating one of both controllers 14a and 14b shown in Figure 1 in detail, and parts corresponding to those in Figure 1 use the same reference symbols.

As shown in the drawing, 14a-1 and 14b-1 denote microcomputers provided with such ROM for storing a processing program, RAM for memorizing various data, or CPU for operating various data, 14a-2 and 14b-2 denote external interfaces connected to external devices such as the image processor 15 or the optical range finders 3a and 3b and simultaneously connecting both controllers 14a and 14b to each other, 14a-3 and 14b-3 denote motor controllers of each servomotor 21a through 21e, 14a-4 denotes an X-axis driver for driving the servomotor 21a, 14a-5 denotes a Y-axis driver for driving the servomotor 21b, 14a-6 denotes a  $\theta$ -axis driver for driving the servomotor 21e, 14b-4 and 14b-5 denote Z-axis drivers for driving the servomotors 21c and 21d, and E denotes an encoder.

The RAM installed in each microcomputer 14a-1 and 14b-1 stores various data indicating a paste pattern or a nozzle exchange inputted from the keyboard 19, data measured by the optical range finders 3a and 3b, and various data generated by a processing of the microcomputers 14a-1 and 14b-1.

Next, processing operations of both controllers 14a and 14b when drawing a paste pattern will now be explained. In addition, in flow charts shown in Figure 4 and Figures thereafter, a reference symbol S denotes a step. In each drawing, if the flow of the process is a single flow, the main controller 14a performs the

process. Contrarily, if the flow of the process is a double flow, the process positioned on the left side of the flow chart is performed by the main controller 14a and those on the right side of the flow chart is performed by the auxiliary controller 14b.

5        As illustrated in Figure 4, when power is applied (S100), an initial establishment of the paste applicator is carried out (S200). In this initial establishment, as illustrated in Figure 5, the Y-axis table 6 and the  $\theta$ -axis table 8 are positioned at predetermined original point positions (S211), data for a paste pattern is set, namely, data NZL-N for a nozzle to be used, data for a discharge pressure of the paste and the height of the nozzle which are related to the height of the paste pattern data for a position to initiate the paste discharge, and data for a position with respect to a relation between the paste pattern and the substrate 7 are established. Such data is stored in the RAM installed in the main controller 14a (S212), and then data for a termination point of the paste discharge is established (S213). Afterwards, the Z-axis tables 4a and 4b are positioned at predetermined original point positions (S221), and finally the data with respect to the paste pattern having established in S212 is moved and stored from the RAM mounted in the main controller 14a to the RAM mounted in the auxiliary controller 14b (S222). Here, the keyboard 19 is used to input the data for those establishments. Furthermore, when the data NZL-N of the nozzle to be used is 1, only the nozzle 1a is used and the nozzle 1b is not used for drawing the paste pattern.

After completing these initial establishments, as illustrated in Figure 4, the substrate 7 for drawing the paste pattern thereon is mounted on the sucking base 13 to be absorbed and fixed thereto, and a process for determining a position of

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the substrate 7 is performed (S400).

S400 will now be explained with reference to Figure 6.

As illustrated in Figure 6, first, a position determining mark having previously provided to the substrate 7 mounted on the sucking base 13 is  
5 photographed by the image-identifying cameras 11a and 11b (S401), and a central position of the position determining mark within a visual field of the image-identifying cameras 11a and 11b is obtained by an image processing (S402). Afterwards, a misalignment amount between the center of the visual field and the central position of the position determining mark is yielded (S403), and using this  
10 misalignment amount, each movement amount of the Y-axis table 6 and the  $\theta$ -axis table 8 required for moving the substrate 7 to a desired position is calculated (S404). Thereafter, this movement amount calculated is converted into an operation amount of the servomotors 21a, 21b and 21e (S405), and thus the servomotors 21a, 21b and 21e are driven by this operation amount. As a result,  
15 each table 6 and 8 move and thus the substrate 7 can move to the desired position.(S406).

When the movement of the substrate 7 is completed, the position determining mark on the substrate 7 is re-photographed by the image-identifying cameras 11a and 11b, and a center (central position) of the position determining  
20 mark within the visual field of the cameras 11a and 11b is measured (S407). A misalignment between the center of the visual field and the mark center is measured to be stored in the RAM of the microcomputer 14a as a misalignment amount of the position of the substrate 7 (S408). Moreover, it is checked whether the position misalignment amount is within the allowable range having explained in  
25 Figure 2, for instance, within a range of a value under one second (S409). When it

is checked that the misalignment amount is within this range, the process of S400 is completed. when it is checked that the misalignment amount is over the range, series of such processes are re-performed by moving back to S404 for determining the position of the substrate 7. Thereafter, those processes are  
5 repeatedly carried out until the position misalignment amount of the substrate 7 gets within the range of the value.

Accordingly, the position of the substrate 7 can be determined such that the drawing point on the substrate 7 at which a drawing is desirably initiated is prevented from being deviated from a predetermined range directly under the  
10 paste discharge port of each nozzle 1a and 1b.

As still illustrated in Figure 4, when S400 is completed, a process for forming a paste film (S500) is carried out, which will now be explained with reference to Figure 7.

As illustrated in Figure 7, the main controller 14a moves the substrate 7  
15 into a position where the drawing is initiated (S511). The substrate 7 has already been located at the desired position according to the process for determining the position of the substrate 7 (S400 in Figure 4) having mentioned, thereby moving the substrate 7 into the drawing initiation point with high precision in this S511. The auxiliary controller 14b, on the other hand, moves the nozzles 1a and 1b into  
20 a position having a predetermined height (S521). That is, the facing interval (distance) from the paste discharge port of the nozzles 1a and 1b to the surface of the substrate 7 is set to be the same as the thickness of the paste film to be formed. When it is notified that the movement of the nozzles 1a and 1b are completed (S522), the main controller 14a moves back to S512 to initiate a  
25 movement of a pattern of the substrate 7 from the drawing initiation point, and thus

moves back to S513 in which the nozzles 1a and 1b initiate the paste discharge. Simultaneously, the auxiliary controller 14b measures concavo-convex on the surface of the substrate 7 by inputting the data of the facing interval (distance) between the paste discharge port of each nozzle 1a and 1b and the substrate 7  
5 measured by the optical range finders 3a and 3b (S523). Furthermore, on the basis of this measured data, whether the aforementioned measurement point of the optical range finders 3a and 3b passes the paste film is decided (S524). For instance, when the measured data of the optical range finders 3a and 3b is over a designated allowable value for the facing interval (distance), the measurement  
10 point is decided to be positioned on the paste film.

When the measurement point of the optical range finders 3a and 3b is not positioned on the paste film, compensation data is created to move the Z-axis tables 4a and 4b on the basis of the measured data (S525). The Z-axis tables 4a and 4b are driven so as to individually compensate the height of each nozzle 1a  
15 and 1b, and accordingly the position of each nozzle 1a and 1b toward the Z-axis direction is maintained in a designated value (S526). Accordingly, when it is determined that the measurement point is passing the paste film, the height of each nozzle 1a and 1b is not compensated but maintained in the height before the determination. Furthermore, when the measurement point is passing the paste film  
20 of a very small width, the concavo-convex of the substrate 7 is not changed, and accordingly a discharge shape of the paste has no change and a paste pattern with a desired thickness can be drawn even if the height of each nozzle 1a and 1b is not compensated.

Next, the main controller 14a decides whether the paste discharge is  
25 terminated (S514). When the discharge is terminated (S515), the main controller



14a decides whether partial patterns are completely formed. When the partial patterns are not completely formed, the main controller 14a moves back to a process for initiating the paste discharge (S513). Conversely, when the partial patterns are completed, it is notified of lifting the nozzles 1a and 1b (S517), and  
5 the auxiliary controller 14b performs the process for lifting the nozzles (S528). The main controller 14a further decides whether every patterns are completely formed on the substrate 7 (S518). When requiring further patterning, the main controller 14a moves back to the process for moving the substrate 7 into the drawing initiation point (S511) and the process for setting the height of each nozzle 1a and  
10 1b (S521) to repeat such series of processes. When every patterns are completely formed, the process for forming the paste film (S500) is terminated.

That is, S514 denotes the process for deciding whether the patterning operation which is continuously ongoing reaches the termination point of the paste pattern. These termination points are not always termination points with respect to  
15 the entire pattern with the desired shape to pattern on the substrate 7. That is, the entire pattern with the desired shape may be composed of a plurality of partial patterns divided into one another, and the partial patterns are composed of a discontinuous patterns. Accordingly, in S518 is performed a process for deciding whether the patterning operation reaches the termination point of every available  
20 patterns. On the other hand, the auxiliary controller 14b always decides whether the nozzles 1a and 1b should be lifted to a position for shifting them away. When it is not required to lift the nozzles 1a and 1b, these series of processes are repeatedly performed by returning the process for measuring concavo-convex on the surface of the substrate (S523). As a result, when the measurement point  
25 completely passes the paste film, the height of each nozzle is compensated again.

The process for forming the paste film (S500) will now be explained in detail.

First, the process for moving the nozzles in S521 illustrated in Figure 7 will now be explained with reference to Figure 8.

5 A value of the data NZL-N for the nozzles which has been established in S212 and stored in the RAM of the auxiliary controller 14b in S222 as illustrated in Figure 5 is compared and decided (S521a). When the data NZL-N is 2, the nozzles 1a and 1b sequentially move into a designated height (S521b and S521c). When the data NZL-N is not 2, only the nozzle 1a moves (S521c).

10 Next, the paste discharge process in the main controller 14a in S512 illustrated in Figure 7 will be explained with reference to Figure 9.

Even in the paste discharge process, first, similar to S521a in Figure 8, the value of the data NZL-N for the nozzles is compared and decided (S521a). When the data NZL-N is 2, the paste discharge is sequentially initiated from each paste  
15 discharge port of the nozzles 1a and 1b (S512b and S512c). When the data NZL-N is not 2, the paste discharge is initiated only from the nozzle 1a (S512c).

Furthermore, the process for measuring concavo-convex on the surface of the substrate in the auxiliary controller 14b of S523 illustrated in Figure 7 will now be explained with reference to Figure 10.

20 First, similar to S521a in Figure 8 or S512a in Figure 9, the value of the data NZL-N for the nozzles is compared and decided (S523a). When the data NZL-N is 2, the facing interval (distance) between the nozzles 1a and 1b and the surface of the substrate 7 is sequentially measured by each optical range finder 3a and 3b (S523b and S523c). When the data NZL-N is not 2, only the facing interval  
25 between the nozzle 1a and the surface of the substrate 7 is only measured by the

optical range finder 3a (S523c). This measured data is stored in the RAN installed in the microcomputer 14b-1 illustrated in Figure 3. Afterwards, the stored data is used for the further process for deciding whether the measurement point is on the paste film (S524) or the process for calculating Z-axis compensation data (S525).

5 That is, in the process for deciding whether the measurement point is on the paste film in S524, as illustrated in Figure 11, it is decided whether a measurement point of the nozzle 1a by the optical range finder 3a is passing the paste film which has already been drawn (S524a). When it is decided that the measurement point is passing it through, a flag NZLF1 is set to 1 (S524b). when it  
10 is decided that the measurement point is not passing it through, the flag NZLF1 is set to 0 (zero) (S524c). Afterwards, it is decided whether a measurement point of the nozzle 1b by the optical range finder 3b is passing the paste film which has already been drawn (S524d). When it is decided that the measurement point is passing it through, a flag NZLF2 is set to 1 (S524e). When it is decided that the  
15 measurement point is not passing it through, the flag NZLF2 is set to 0 (zero) (S524f). The results from these decisions may be used for a process for compensating a height of each nozzle to be explained later.

Furthermore, in the process for calculating Z-axis compensation data in S525, as illustrated in Figure 12, the value of data NZL-N for the nozzles is  
20 compared and decided (S525a). When the data NZL-N is 2, the compensation data for the nozzles 1a and 1b is sequentially calculated (S525b and S525c). When the data NZL-N is not 2, the compensation data only for the nozzle 1a is calculated (S525c). This measured data is stored in the RAM installed in the microcomputer 14b-1 illustrated in Figure 3.

25 Finally, the process for compensating the height of each nozzle in S526 of

Figure 7 will now be explained with reference to Figure 13.

First, it is decided whether the flag NZLF1 of the nozzle 1a side set by the deciding process of Figure 11 stands or not (S526a). When the flag NZLF1 does not exist, namely, when the measurement point is not passing the paste film, S526b is carried out, and the calculated data obtained by the process for calculating the compensation data of the nozzle 1a (S525c in Figure 12) is deciphered by the RAM of the microcomputer 14b-1, thereafter performing the compensation for the height of the nozzle 1a (S526b). When the flag NZLF1 does not stand, which means that the measurement point is passing the paste film, S526c is carried out. As a result, the height of the nozzle 1a is not compensation but maintained as the height before passing the paste film. Similarly, in S526c, it is decided whether the flag NZLF2 of the nozzle 1b side set by the deciding process of Figure 11 stands or not. When the flag NZLF2 is 0 (zero) which means that the measurement point is not passing the paste film, S526d is carried out, and the calculated data obtained by the process for calculating the compensation data of the nozzle 1b is deciphered from the RAM, thereafter performing the compensation for the height of the nozzle 1b. When the flag NZLF2 is 1 which means the measurement point is passing the paste film, the height of the nozzle 1b is not compensated but maintained as the height before passing the paste film, thereby completing the process.

Accordingly, when the process for compensating the nozzle height (S526) is completed, S527 in Figure 7 is carried out, and then whether there is a command to lift the nozzle up to the shift position. If there is not, it denotes that the paste pattern is being drawn. Therefore, the processes are repeated from the process for measuring concavo-convex on the surface of the substrate (S523).

However, as aforementioned, if the process for forming the paste film for the pattern with the desired shape (S500) is completed, it denotes the paste drawing for the substrate 7 which is being laid on the sucking base 13 is completed. Hence, S600 in Figure 4 is performed to carry the substrate 7 out of the sucking base 13, and then S700 is performed to decide whether all of the process would be stopped. That is, when the paste is drawn on plural sheets of substrates 7 with the same pattern, series of processes from S300 to S700 are repeatedly performed, thereby enabling massive production.

Thus, as aforementioned in those embodiments, the main controller 14a controls the relative position relation of a longitudinal direction between the substrate 7 and the nozzles 1a and 1b to manage the patterning position of the paste pattern, and the auxiliary controller 14b controls the height of each nozzle 1a and 1b to manage the height for drawing the paste. Although this auxiliary controller 14b divides functions of the main controller 14a which manages the whole processes, both the controllers 14a and 14b exchange a little amount of data for lifting the nozzles to thereby integrally control the series of processes of the drawing. In addition, because the auxiliary controller 14b does not perform any process other than the process for managing the height of each nozzle 1a and 1b, the auxiliary controller 14b can shorten the period for managing the height, that is, increase the number of times for measuring data by the optical range finders 3a and 3b and compensating the height. As a result, the height of each nozzle 1a and 1b can exactly be matched with the concavo-convex on the surface of the substrate. Therefore, the desired width or height of the paste pattern drawn by using each nozzle 1a and 1b can be achieved. Furthermore, because the measured data by the optical range finders 3a and 3b is stored in the storage unit

of the auxiliary controller 14b, the data exchange can be performed at a high speed to thus prevent a delay of the processes.

Moreover, the main controller 14a gets free from the height compensation of the nozzles 1a and 1b based on the result measured by the optical range finders 3a and 3b, and accordingly can draw fine patterns by minutely driving the Y-axis and  $\theta$ -axis tables 6 and 8 on the basis of the data from the encoder E. As a result, the main controller 14a can minutely perform the management for the whole processes.

That is, in the embodiment, since such complicated control can be avoided by the division, the plurality of paste patterns with the desired shape can simultaneously drawn with high precision at a high speed and reliability can be improved by the precise management.

Furthermore, in the aspect of the device fabrication, the soft for processing the main and auxiliary controllers 14a and 14b can be an independent module, development therefor and debug operation can be facilitated and high reliability can be ensured in the processing soft.

For instance, when forming a paste pattern with a sectional shape of an open bottle of which initiation point and termination point for the patterning are close to each other, a discharge pressure of the paste, positions of the Y-axis and  $\theta$ -axis tables 6 and 8, heights of both nozzles 1a and 1b should be equal in the initiated point and the completed point of the pattern. However, in the embodiment, the main and auxiliary controllers 14a and 14b divide control processes therefore by an autonomous dispersion process, which leads to an easy drawing for the paste pattern in which the shapes of the initiated and completed points are not scattered.

In addition, in order to shorten a time taken by the process for initially setting the applicator (S200), various data required is previously stored in an external storage device 16 which is connected to the external interface 14a-2 and in which a storage unit such as IC card, floppy disc, hard disc, or the like is mounted. Such data may then be moved into the RAM of the microcomputers 14a-1 and 14b-1. Furthermore, the measured data is stored in the external storage device 16 to enlarge memory capacity of the RAM of the microcomputers 14a-1 and 14b-1, or data for the result from the decision is stored in the external storage device 16 to be used later.

Although the case of drawing a plurality of paste patterns on a sheet of substrate has been explained in the aforementioned embodiments, it may be possible that plural sheets of substrates are sucked in the sucking base to simultaneously draw the same paste pattern on each substrate. At this time, it is advantageous for an alignment of each substrate to control each driving of X-axis and Y-axis tables (not shown) of the Z-axis tables 4a and 4b. Likewise, if the image-identifying cameras 11a and 11b have X-axis and Y-axis tables, the driving for these tables can be controlled according to the position deciding marks of substrates with a different size, and the image-identifying cameras 11a and 11b can be moved to predetermined places, thereby drawing the paste pattern on the substrates with various sizes.

#### [Effect of the Invention]

As described so far, in the paste applicator according to the present invention, the facing interval between the nozzles and the substrate can independently controlled by adjusting the relative positions of the longitudinal

direction between the nozzles and the substrate, whereby the paste pattern can be formed with making the plurality of nozzles follow the concavo-convex of the surface of the substrate which each nozzle faces. As a result, a plurality of paste patterns with the desired shape can simultaneously be drawn on the substrate with high precision at a high speed. Therefore, in the facilities for massive production, even if not making producing lines complicated or not enlarging the spaces for production facilities, productivity can easily be increased and product price can remarkably reduced.

10 [Brief Description for the Drawing]

Figure 1 is a schematic perspective view showing an embodiment of the paste applicator according to the present invention.

Figure 2 is a perspective view showing an arrangement relation between nozzles and optical range finders according to the same embodiment.

15 Figure 3 is a block diagram showing a detailed example for controllers according to the same embodiment.

Figure 4 is a flow chart showing an overall operation of the same embodiment.

20 Figure 5 is a flow chart showing an initial establishing process for a paste applicator in Figure 4.

Figure 6 is a flow chart showing a process for deciding a position of a substrate in Figure 4.

Figure 7 is a flow chart showing a process for forming a paste film in Figure 4.

25 Figure 8 is a flow chart showing a process for moving nozzles in Figure 7.



Figure 9 is a flow chart showing a process for discharging a paste in Figure 7.

Figure 10 is a flow chart showing a process for measuring concavo-convexes on a surface of a substrate in Figure 7.

5        Figure 11 is a flow chart showing a process for deciding whether to pass the paste film in Figure 7.

Figure 12 is a flow chart showing a process for calculating Z-axis compensation data in Figure 7.

10       Figure 13 is a flow chart showing a process for compensating nozzle height in Figure 7.

[Explanation for Reference Symbol]

	1a, 1b	nozzle
	2a, 2b	paste syringe
15	3a, 3b	optical range finder
	4a, 4b	Z-axis table
5		X-axis table
	6	Y-axis table
	7	substrate
20	8	$\theta$ -axis table
	9	mounting unit
	10	Z-axis table supporter
	11a, 11b	image-identifying camera
	12a, 12b	nozzle support unit
25	13	sucking base

- 14a, 14b      controller
- 15      image processor
- 16      external storage device
- 17      image monitor
- 5      18      display
- 19      keyboard
- 21a~21e      servomotor